(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 749 087 B1

(12) # EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:
09.08.2023 Bulletin 2023/32

(21) Application number: **19705405.9**

(22) Date of filing: **07.02.2019**

(51) International Patent Classification (IPC):
A01J 5/007 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
A01J 5/007

(86) International application number:
PCT/SE2019/050101

(87) International publication number:
WO 2019/156619 (15.08.2019 Gazette 2019/33)

(54) **CONTROL UNIT, METHOD AND COMPUTER PROGRAM FOR A MILKING SYSTEM**

STEUEREINHEIT, VERFAHREN UND COMPUTERPROGRAMM FÜR EIN MELKSYSTEM

UNITÉ DE COMMANDE, PROCÉDÉ ET PROGRAMME INFORMATIQUE POUR UN SYSTÈME DE TRAITE

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **09.02.2018 SE 1850142**

(43) Date of publication of application:
16.12.2020 Bulletin 2020/51

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EP 3 749 087 B1

Description

TECHNICAL FIELD

[0001] The present invention relates generally to machine milking of dairy animals. More particularly the invention relates to a control unit for a milking system and method of controlling a milking system. The invention also relates to a computer program and a non-volatile data carrier.

BACKGROUND

[0002] As new and more advanced milking equipments are developed, the milking process has become completely automated, or at least almost. In such automatic milking systems, the low involvement of human operators requires that the milking system is capable of taking adequate decisions as when to stop extracting milk from each animal. Due to the wide variety in milk flow characteristics between different animals as well as for a particular animal between different milking occasions, it is a far from trivial task to determine the optimal milking time.

[0003] DE 36 09 275 A1 describes a milk removal method, wherein the flow of milk is detected in at least one teat, and based thereon; a milk-flow profile is derived. The milk-flow profile indicates a temporal dependence of the quantity of milk obtained within individual pulsation cycles. This, in turn, serves as a basis for a vacuum application parameter for a following milking operation.

[0004] WO 03/000042 A1 discloses another example of a control unit and method for determining the take-off time when milking should be stopped.

[0005] V. Tančin et al., "Sources of Variation in Milk Flow Characteristics at Udder and Quarter Levels", Journal of Dairy Science, No. 89, American Diary Science Association, 2006, pp 978-988 discusses milk flow patterns and variations in milk flow characteristics throughout the lactation cycle. Inter alia, the longest duration of decline phase was found at the beginning and end of lactation in quarters with high peak flow rate and in rear quarters. It is also speculated if cow preparation for milking and vacuum modification plays a role in the duration of decline phase at quarter level.

[0006] However, there is yet no example of a fully automatic procedure for determining an individually adapted milking time that is optimal for each animal.

SUMMARY

[0007] The object of the present invention is therefore to offer a solution for controlling a milking machine to stop the milk extraction at a point in time that is ideal with respect to both long-term milk yield and animal health.

[0008] According to one aspect of the invention, the object is achieved by a control unit for a milking system, where the control unit includes processing circuitry and interfaces configured to receive at least one parameter representing at least one measured flow of milk being extracted from at least one teat of an udder of an animal that is milked via at least one teatcup. The at least one parameter may thus either represent a common flow of milk from all the teats of the udder, or a specific flow of milk from an individual teat. Based on the at least one parameter, the processing circuitry is configured to control the extraction of milk to be stopped. More precisely, the processing circuitry is configured to determine a take-off time when the milking shall be stopped based on first and second criteria. The first criterion indicates that the at least one flow has reached a decline phase. The second criterion indicates that the at least one flow decreases faster than a threshold slope, and the take-off time is determined in response to the second criterion being fulfilled on or after a point in time when the first criterion has been fulfilled.

[0009] The processing circuitry is configured to determine that the at least one flow has reached the decline phase based on a series of flow values registered during a current milking, and/or historic milk-flow-profile data for the animal being milked.

[0010] This control unit is advantageous because it provides a milking time being just right for animals that have widely different milk-flow profiles, for example in terms of rise time, plateau-phase flow level and the extension of the decline phase.

[0011] It is advantageous to determine that the decline phase has been reached based on a series of flow values registered during a current milking or a historic milk-flow-profile data for the animal being milked. Namely, in the former case, the decision-making can be made independent from animal identity, and in the latter case the basis for the decision can be gradually enhanced over time.

[0012] It is further advantageous to register a series of flow values because such data may serve as a basis for determining a transition point between the plateau phase and the the decline phase in the milk-flow profile. If, for example, an average time derivative of the milk flow changes from lying in an interval of relatively low time derivative, positive or negative, to a relatively high negative value, this may be construed as the end of the plateau phase and the beginning of the decline phase, i.e. that the first criterion is fulfilled.

[0013] According to one embodiment of this aspect of the invention, the stopping of the extraction of milk involves detaching at least one teatcup from a respective teat of the animal's udder, shutting off a milking vacuum to at least one teatcup and/or shutting off a pulsator vacuum to at least one teatcup. Thus, the milking can be stopped in a way that is adapted to the specific type of equipment used.

[0014] According to another embodiment of this aspect of the invention, the processing circuitry is configured to determine that the second criterion is fulfilled exclusively based on that the at least one flow decreases faster than the threshold slope. Thus, the teatcup detachment can be made fully independent from the milk flow level.

[0015] According to yet another embodiment of this aspect of the invention, the processing circuitry is configured to set the second criterion dynamically based on an average level of the flow during a plateau phase preceding the decline phase. This means that, if the average level of the flow during the plateau phase is comparatively high, the second criterion specifies a relatively steep threshold slope; and conversely, if the average level of the flow during the plateau phase is comparatively low, the second criterion specifies a relatively gentle threshold slope. In other words, the stop criterion requires a steeper decline phase for triggering in high milk-flow profiles than in low milk-flow profiles. Thus, in general, animals with a low overall milk flow will be allowed longer milking times than animals with high overall milk flow.

[0016] The processing circuitry is configured to determine the take-off time in further response to a third criterion. This criterion is fulfilled if, after that, the first criterion has indicated that the flow has reached the decline phase, the flow decreases below a threshold level (before the second criterion is fulfilled). Consequently, even if the decline phase is very gentle, the milking will be aborted at an appropriate point, and over milking can be avoided.

[0017] According to one embodiment of this aspect of the invention, the processing circuitry is configured to set the first and second criteria based on an algorithm adapted to leave a particular estimated amount of milk in the udder after that the extraction of milk has stopped. Thereby, irrespective of the specific animal's current milk-flow profile, an appropriate milking will be carried out.

[0018] According to still another embodiment of this aspect of the invention, the processing circuitry is configured to set the third criterion dynamically based on an average level of the flow during a plateau phase preceding the decline phase, such that: if the average level of the flow during the plateau phase is comparatively high, the third criterion specifies a relatively high threshold level; and conversely, if the average level of the flow during the plateau phase is comparatively low, the third criterion specifies a relatively low threshold level. Analogous to the above, in general, this leads to that animals with a low overall milk flow will be allowed longer milking times than animals with high overall milk flow.

[0019] According to yet another embodiment of this aspect of the invention the processing circuitry is configured to determine the take-off time on the further basis of: historic milk-yield data for the animal, historic milk-flow-profile data for the animal, a current lactation phase of the animal, an age of the animal, and/or a health status of the animal. Of course, this further improves the chances of obtaining an individually optimal milking time.

[0020] According to another aspect of the invention, the object is achieved by an automatic milking method comprising: receiving at least one parameter representing at least one measured flow of milk being extracted from at least one teat of an udder of an animal that is milked via at least one teatcup; and based on the at least one parameter, controlling the extraction of milk to be stopped. Specifically, a take-off time when the milking shall be stopped is determined based on first and second criteria, where the first criterion indicates that the at least one flow has reached a decline phase, and the second criterion indicates that the at least one flow decreases faster than a threshold slope. The take-off time is determined in response to the second criterion being fulfilled on or after a point in time when the first criterion has been fulfilled. The advantages of this method, as well as the preferred embodiments thereof, are apparent from the discussion above with reference to the control unit.

[0021] According to a further aspect of the invention the object is achieved by a computer program loadable into a non-volatile data carrier communicatively connected to a processing unit. The computer program includes software for executing the above method when the program is run on the processing unit.

[0022] According to another aspect of the invention the object is achieved by a non-volatile data carrier containing the above computer program.

[0023] Further advantages, beneficial features and applications of the present invention will be apparent from the following description and the dependent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] The invention is now to be explained more closely by means of preferred embodiments, which are disclosed as examples, and with reference to the attached drawings.

Figure 1	shows a first embodiment of the invention adapted to be implemented in connection with a milking cluster for udder milking;
Figure 2	shows a second embodiment of the invention adapted to be implemented in connection with individual teatcups for quarter milking;
Figures 3a-c	show diagrams exemplifying how a set of proposed stop criteria can be applied depending on the characteristics of milk-flow profile; and
Figures 4-5	illustrate, by means of flow diagrams, a general milking method according to the invention and an embodiment thereof respectively.

DETAILED DESCRIPTION

[0025] Figure 1 shows a milking cluster 110 for udder milking, i.e. common milking of all the teats of an animal's udder 105. Here, a pulsator controller 135 is arranged to control a pulsator vacuum PV from a vacuum pump 130 to be applied repeatedly to milking teat cups 111, 112, 113 and 114 of the milking cluster 110.

[0026] Typically, the vacuum pump 130 also provides a milking vacuum MV in a milk conduit 120 through which extracted milk is transported away from the udder 105.

[0027] The milking claw 115 is connected to the four teatcups 111, 112, 113 and 114 via respective milk and vacuum hoses. The teatcups 111, 112, 113 and 114, in turn, are attached to a respective teat of the udder 105. The pulsator vacuum PV is applied to all the four teatcups 111, 112, 113 and 114. Milk is extracted from the udder 105, collected in the milking claw 115 and forwarded through a milk conduit 120. A flow meter 125 registers a parameter representing a measured milk flow f(t) in the milk conduit 120. The measured milk flow f(t) may be registered either continuously or repeatedly at discrete time instances.

[0028] In any case, the parameter that represents the measured milk flow f(t) is forwarded to a control unit 150, which, in turn, is adapted to influence how a milking system is operated via a control signal Ctrl.

[0029] The term "milking system" here has a general meaning and may include e.g. a single milking cluster 110, a milking machine or a milking robot.

[0030] The control unit 150 contains processing circuitry and interfaces in order to enable the control unit 150 to receive data and signals, perform various analyses of said data and signals, and generate output, for example in form of the control signal Ctrl. More precisely, the control unit 150 is configured to receive the parameter representing the measured flow f(t) of milk being extracted from the udder 105 and based on this parameter control the extraction of milk to be stopped by means of the control signal Ctrl.

[0031] The extraction of milk may for example be stopped by detaching the teatcups 111, 112, 113 and 114 from a respective teat of the udder 105. A withdrawal cylinder or a milking robot may perform such a detachment in response to the control signal Ctrl. Alternatively, or in addition thereto, the pulsator vacuum PV and/or the milking vacuum MV may be shut off to the teatcups 111, 112, 113 and 114.

[0032] Referring now to the diagram in Figure 3a, we will explain the criteria based upon which the processing circuitry in the control unit 150 is configured to determine a take-off time t_{TO} when the milking shall be stopped.

[0033] The horizontal axis of the diagram in Figure 3a represents time t, and the vertical axis represents the registered milk flow f(t) as a function of time t. We presume that the milking vacuum MV and the pulsator vacuum PV is applied to the teatcups 111, 112, 113 and 114 at t = zero, and that the resulting extraction of milk is initiated at a t_{in} later point in time $t = t_0$. Then, a rise phase Ph_r follows during which the milk flow f(t) increases relatively rapidly. Subsequently, the rise phase Ph_r ends and a plateau phase Ph_{plt} follows. This means that the milk flow f(t) lies rather stable at a level. In Figure 3a, this is represented by an average level $F_{plt}1$ of the milk flow f(t). After that milk has been extracted for some time t_1, say 100 - 700 seconds, a decline phase Ph_{decl} is initiated in which the milk flow f(t) begins to decrease. As will be discussed below, the slope at which the milk flow f(t) decreases in the decline phase Ph_{decl} may vary substantially. Figure 3a exemplifies a milk-flow profile with a comparatively steep slope in its decline phase Ph_{decl}.

[0034] According to one embodiment of the invention, determining that the milk-flow profile transitions from the rise phase Ph_r to the plateau phase Ph_{plt} is made based on a series of registered flow values. More precisely, the control unit 150 is preferably configured to study a temporal variation of the milk flow f(t) described by these flow values. For example, if an average time derivative of the milk flow f(t) changes from a relatively high positive value to lie in an interval of relatively low time derivative, positive or negative, the control unit 150 may construe this as the end of the rise phase Ph_r and the beginning of the plateau phase Ph_{plt}. Analogously, if the average time derivative of the milk flow f(t) changes from lying in the interval of relatively low time derivative, positive or negative, to a relatively high negative value, the control unit 150 may construe this as the end of the plateau phase Ph_{plt} and the beginning of the decline phase Ph_{decl}.

[0035] It has been found that it is beneficial both for the long-term milk yield and for the animal health if approximately the same amount of milk is left in the udder 105 after each milking. Therefore, according to one embodiment of the invention, the processing circuitry in the control unit 150 is configured to generate the control signal Ctrl at such a point in time t_{TO} that a particular estimated amount of milk M_{res} is left in the udder 105 after that the extraction of milk has stopped. This is accomplished via first and second criteria.

[0036] The first criterion indicates that the milk flow f(t) has reached the decline phase Ph_{decl}, and the second criterion indicates that the milk flow f(t) decreases faster than a threshold slope. In Figure 3a, the second criterion is symbolized via a dot-dashed line $s_{crit}1$. The take-off time t_{TO} is determined in response to fulfillment of the second criterion on or after the point in time t_1 when the first criterion has been fulfilled.

[0037] Determining if the decline phase Ph_{decl} has been reached can be made via signal processing that is based on a series of flow values registered during a current milking, via historic milk-flow-profile data D_{mfp} for the animal being milked, or both. If historic milk-flow-profile data D_{mfp} are to be used, a database 160 is communicatively linked to the control unit 150, so that milk-flow values f(t) can be both recorded and read repeatedly during the milking process. Figure 2 shows an embodiment of the invention where such a database 160 is included.

[0038] Referring now to Figure 3b, we will discuss further aspects of the stop criteria. As is apparent from Figure 3b, the milk-flow profile has a less steep decline phase Ph_{decl} than in Figure 3a. If the decline phase Ph_{decl} is sufficiently gentle it may be the case that the second criterion, e.g. as symbolized via the dot-dashed line $s_{crit}1$, in Figure 3a, is never fulfilled. Therefore, according to the invention, the processing circuitry is configured to determine the take-off time t_{TO} in further response to a third criterion, which is fulfilled if, after that the first criterion has indicated that the milk flow f(t) has reached the decline phase Ph_{decl}, the milk flow f(t) decreases below a threshold level. In Figure 3b, this level is represented by $F_{th}1$. Thereby, over milking can be avoided also for animals whose milk-flow profile has a very slightly sloping decline phase Ph_{decl}. Preferably, the threshold level $F_{th}1$ is set such that the particular estimated amount of milk M_{res} is left in the udder 105 after that the extraction of milk has stopped. A total milking time t_M is measured from t_0 until the take-off time t_{TO}. Thus, at the take-off time t_{TO}, the particular estimated amount of milk M_{res} should be left in the udder 105.

[0039] According to one embodiment of the invention, the processing circuitry in the control unit 150 is configured to set the second criterion dynamically based on the average level F_{plt} of the milk flow f(t) during a plateau phase Ph_{plt} that precedes the decline phase Ph_{decl}. This will be explained with reference to Figure 3c, which shows a diagram over a milk-flow profile where an average level $F_{plt}2$ of the milk flow f(t) during the plateau phase Ph_{plt} is comparatively low. Here, in order to leave the particular estimated amount of milk M_{res} in the udder 105 at the take-off time t_{TO}, a relatively gentle threshold slope $s_{crit}2$ is set because the average level $F_{plt}2$ of the milk flow f(t) during the plateau phase Ph_{plt} is comparatively low. Conversely, as shown in Figure 3a, if the average level $F_{plt}1$ of the milk flow f(t) during the plateau phase Ph_{plt} is comparatively high, the second criterion is set to specify a relatively steep threshold slope $s_{crit}1$.

[0040] Similarly, also aiming at leaving the particular estimated amount of M_{res} in the udder 105, according to one embodiment of the invention, the processing circuitry in the control unit 150 is configured to set the third criterion dynamically based on the average level F_{plt} of the flow f(t) during the plateau phase Ph_{plt} preceding the decline phase Ph_{decl}. This means that, if the average level $F_{plt}1$ of the milk flow f(t) during the plateau phase Ph_{plt} is comparatively high, the third criterion specifies a relatively high threshold level $F_{th}1$, for example as illustrated in Figure 3b. Conversely, if the average level $F_{plt}2$ of the milk flow f(t) during the plateau phase Ph_{plt} is comparatively low, the third criterion specifies a relatively low threshold level $F_{th}2$, for example as illustrated in Figure 3c.

[0041] Figure 2 shows a second embodiment of the invention, which is adapted to be implemented in connection with quarter milking, i.e. where the milk extraction can be controlled individually from each of the four teatcups 111, 112, 113 and 114 respectively.

[0042] Here, a particular flow meter 126, 127, 128 and 129 is arranged on a respective milk hose 121, 122, 123 and 124 from each of the teatcups 111, 112, 113 and 114, and the control unit 150 is configured to receive parameters representing measured milk flows $f_1(t)$, $f_2(t)$, $f_3(t)$ and $f_4(t)$ from each of the teatcups 111, 112, 113 and 114 respectively. The control unit 150 is further configured to control Ctrl the extraction of milk to be stopped based on said parameters, so that the take-off time t_{TO} when the milking shall be stopped is determined based on: a first criterion indicating that at least one of the milk flows $f_1(t)$, $f_2(t)$, $f_3(t)$ and/or $f_4(t)$ has reached a decline phase Ph_{decl}; and a second criterion indicating that at least one of the milk flows $f_1(t)$, $f_2(t)$, $f_3(t)$ and/or $f_4(t)$ decreases faster than a threshold slope $s_{crit}1$ or $s_{crit}2$ respectively. Analogous to the above, the take-off time t_{TO} is determined in response to fulfillment of the second criterion on or after a point in time t_1 when the first criterion has been fulfilled.

[0043] Preferably, in the quarter-milking embodiment of the invention illustrated in Figure 2, the stopping of the extraction of milk may involve detaching the specific teatcup(s) of the teatcups 111, 112, 113 and/or 114 from the respective teat(s) of the udder 105 in respect of which teatcup(s) the above first and second criteria have been fulfilled. Alternatively, or in addition thereto, the stopping of the extraction of milk may involve shutting off the milking vacuum MV and/or the pulsator vacuum PV to each teatcup(s) of the teatcups 111, 112, 113 and/or 114 in respect of which teatcup(s) the above first and second criteria have been fulfilled.

[0044] In addition to the above-described first, second and third criteria, it is preferable if the processing circuitry in the control unit 150 is configured to determine the take-off time t_{TO} on the further basis of historic milk-yield data for the animal, historic milk-flow-profile data for the animal, a current lactation phase of the animal, an age of the animal, and/or a health status of the animal. This information may be stored in the database 160, and be retrieved in response to registering an identity of an animal to be milked. As a result, the total milking time t_M can be individually adapted with even better precision.

[0045] It is generally advantageous if the above-described control unit 150 is configured to effect the above-mentioned procedure in an automatic manner by executing a computer program 157. Therefore, the control unit 150 may include a memory unit, i.e. nonvolatile data carrier 153, storing the computer program 157, which, in turn, contains software for making processing circuitry in the form of at least one processor in the control unit 150 execute the above-described actions when the computer program 157 is run on the at least one processor.

[0046] Although the invention is primarily intended to control a system for extracting milk from cows, the proposed solution is equally well applicable for any other kind of livestock animals, such as goats, sheep, pigs, donkeys, yaks or buffaloes. Naturally, if the animal being milked has a number of teats different from four, e.g. two, the above-described quarter-milking scenario is adapted the relevant number of teats.

[0047] In order to sum up, and with reference to the flow diagram in Figure 4, we will now describe the general method according to the invention of controlling a milking system where milk extraction has been initiated.

[0048] In a first step 410, at least one parameter is received, which at least one parameter represents a measured milk flow. Then, in a step 420, it is checked if a first criterion is fulfilled, which indicates that the at least one milk flow has reached a decline phase. If so, a step 430 follows; and otherwise, the procedure loops back to step 410 for continued reception of the milk-flow related parameter(s).

[0049] In step 430 it is checked if a second criterion is fulfilled, which indicates that the at least one milk flow decreases faster than a threshold slope. If so, a step 440 follows; and otherwise, the procedure loops back and stays in step 430.

[0050] In step 440, the milking machine is controlled to stop the extraction of milk. Thereafter, the procedure ends.

[0051] Figure 5 illustrates, by means of a flow diagram, an embodiment of the invention for controlling a milking machine. Here, the initial reference sign 420 represents the above-described steps 410 and 420

[0052] In a step 530 thereafter, it is checked if the second criterion is fulfilled, i.e. if the at least one milk flow decreases faster than a threshold slope. If so, a step 550 follows; and otherwise, the procedure continues to a step 540.

[0053] In step 540 it is checked if the at least one milk flow has decreased below a threshold level. If so, step 550 follows; and otherwise, the procedure loops back to step 530.

[0054] In step 550, the milking machine is controlled to stop the extraction of milk. Thereafter, the procedure ends.

[0055] All of the process steps, as well as any subsequence of steps, described with reference to Figures 4 and 5 may be controlled by means of a programmed processor. Moreover, although the embodiments of the invention described above with reference to the drawings comprise processor and processes performed in at least one processor, the invention thus also extends to computer programs, particularly computer programs on or in a carrier, adapted for putting the invention into practice. The program may be in the form of source code, object code, a code intermediate source and object code such as in partially compiled form, or in any other form suitable for use in the implementation of the process according to the invention. The program may either be a part of an operating system, or be a separate application. The carrier may be any entity or device capable of carrying the program. For example, the carrier may comprise a storage medium, such as a Flash memory, a ROM (Read Only Memory), for example a DVD (Digital Video/Versatile Disk), a CD (Compact Disc) or a semiconductor ROM, an EPROM (Erasable Programmable Read-Only Memory), an EEPROM (Electrically Erasable Programmable Read-Only Memory), or a magnetic recording medium, for example a floppy disc or hard disc. Further, the carrier may be a transmissible carrier such as an electrical or optical signal which may be conveyed via electrical or optical cable or by radio or by other means. When the program is embodied in a signal which may be conveyed directly by a cable or other device or means, the carrier may be constituted by such cable or device or means. Alternatively, the carrier may be an integrated circuit in which the program is embedded, the integrated circuit being adapted for performing, or for use in the performance of, the relevant processes.

[0056] The term "comprises/comprising" when used in this specification is taken to specify the presence of stated features, integers, steps or components. However, the term does not preclude the presence or addition of one or more additional features, integers, steps or components or groups thereof.

[0057] The invention is not restricted to the described embodiments in the figures, but is only limited to the scope of the claims.

Claims

1. A control unit (150) for a milking system, the control unit (150) comprising processing circuitry and interfaces configured to:

receive at least one parameter representing at least one measured flow ($f(t)$; ($f_1(t)$, $f_2(t)$, $f_3(t)$, $f_4(t)$) of milk being extracted from at least one teat of an udder (105) of an animal that is milked via at least one teatcup (111, 112, 113, 114), and based on said at least one parameter control (Ctrl) the extraction of milk to be stopped, wherein the processing circuitry is configured to determine a take-off time (t_{TO}) when the milking shall be stopped based on:

a first criterion indicating that the at least one flow ($f(t)$; ($f_1(t)$, $f_2(t)$, $f_3(t)$, $f_4(t)$) has reached a decline phase (Ph_{decl}), and
a second criterion indicating that the at least one flow ($f(t)$; ($f_1(t)$, $f_2(t)$, $f_3(t)$, $f_4(t)$) decreases faster than a threshold slope ($s_{crit}1$, $s_{crit}2$),

the take-off time (t_{TO}) being determined in response to if the second criterion is fulfilled on or after a point in time (t_1) when the first criterion has been fulfilled, and, if the second criterion has not been fulfilled, the processing circuitry is configured to determine the take-off time (t_{TO}) in further response to a third criterion, which is fulfilled if:
after that the first criterion has indicated that the flow ($f(t)$) has reached the decline phase (Ph_{decl}), the flow ($f(t)$) decreases below a threshold level ($F_{th}1$, $F_{th}2$), and

the processing circuitry is configured to determine that the at least one flow (f(t); (f_1(t), f_2(t), f_3(t), f_4(t)) has reached the decline phase (Ph_{decl}) based on at least one of:

a series of flow values registered during a current milking, and
historic milk-flow-profile data (D_{mfp}) for the animal being milked.

2. The control unit (150) according to claim 1, wherein the at least one parameter represents a common flow of milk (f(t)) from all the teats of the udder (105) of the animal.

3. The control unit (150) according to any one of claims 1 or 2, wherein the stopping of the extraction of milk involves at least one of:

detaching at least one of the at least one teatcup (111, 112, 113, 114) from a respective teat of the udder (105),
shutting off a pulsator vacuum (PV) to at least one of the at least one teatcup (111, 112, 113, 114), and
shutting off a milking vacuum (MV) to at least one of the at least one teatcup (111, 112, 113, 114).

4. The control unit (150) according to any one of the preceding claims, wherein the processing circuitry is configured to set the second criterion dynamically based on an average level (F_{plt}) of the flow (f(t)) during a plateau phase (Ph_{plt}) preceding the decline phase (Ph_{decl}), such that:

if the average level (F_{plt}1) of the flow (f(t)) during the plateau phase (Ph_{plt}) is comparatively high, the second criterion specifies a relatively steep threshold slope (s_{crit}1), and
if the average level (F_{plt}2) of the flow (f(t)) during the plateau phase (Ph_{plt}) is comparatively low, the second criterion specifies a relatively gentle threshold slope (s_{crit}2).

5. The control unit (150) according to any one of the preceding claims, wherein the processing circuitry is configured to determine that the second criterion is fulfilled exclusively based on that the at least one flow (f(t); (f_1(t), f_2(t), f_3(t), f_4(t)) decreases faster than the threshold slope (s_{crit}1, Scrit2).

6. The control unit (150) according to claim 1, wherein the processing circuitry is configured to set the third criterion dynamically based on an average level (F_{plt}) of the flow (f(t)) during a plateau phase (Ph_{plt}) preceding the decline phase (Ph_{decl}), such that:

if the average level (F_{plt}1) of the flow (f(t)) during the plateau phase (Ph_{plt}) is comparatively high, the third criterion specifies a relatively high threshold level (F_{th}1), and
if the average level (F_{plt}2) of the flow (f(t)) during the plateau phase (Ph_{plt}) is comparatively low, the third criterion specifies a relatively low threshold level (Ft_h2).

7. The control unit (150) according to any one of the preceding claims, wherein the processing circuitry is configured to determine the take-off time (t_{TO}) on the further basis of at least one of:

historic milk-yield data for the animal,
historic milk-flow-profile data for the animal,
a current lactation phase of the animal,
an age of the animal, and
a health status of the animal.

8. An automatic milking method comprising:

receiving at least one parameter representing at least one measured flow (f(t); (f_1(t), f_2(t), f_3(t), f_4(t)) of milk being extracted from at least one teat of an udder (105) of an animal that is milked via at least one teatcup (111, 112, 113, 114), and based on said at least one parameter
controlling (Ctrl) the extraction of milk to be stopped, determining a take-off time (t_{TO}) when the milking shall be stopped based on:

a first criterion indicating that the at least one flow (f(t); (f_1(t), f_2(t), f_3(t), f_4(t)) has reached a decline phase (Ph_{decl}), and
a second criterion indicating that the at least one flow (f(t); (f_1(t), f_2(t), f_3(t), f_4(t)) decreases faster than a threshold slope (s_{crit}1, s_{crit}2),

the take-off time (t_{TO}) being determined in response to if the second criterion is fulfilled on or after a point in time (t_1) when the first criterion has been fulfilled, and, if the second criterion has not been fulfilled:
determining the take-off time (t_{TO}) in further response to a third criterion, which is fulfilled if: after that the first criterion has indicated that the flow (f(t)) has reached the decline phase (Ph_{decl}), the flow (f(t)) decreases below a threshold level (F_{th}1, F_{th}2), and
the determining that the at least one flow (f(t); (f_1(t), f_2(t), f_3(t), f_4(t)) has reached the decline phase (Ph_{decl}) is based on at least one of:

a series of flow values registered during a current milking, and
historic milk-flow-profile data (D_{mfp}) for the

animal being milked.

9. The method according to claim 8, wherein the at least one parameter represents a common flow of milk (f(t)) from all the teats of the udder (105) of the animal.

10. The method according to any one of claims 8 or 9, wherein the stopping of the extraction of milk involves at least one of:

detaching at least one of the at least one teatcup (111, 112, 113, 114) from a respective teat of the udder (105),
shutting off a pulsator vacuum (PV) to at least one of the at least one teatcup (111, 112, 113, 114), and
shutting off a milking vacuum (MV) to at least one of the at least one teatcup (111, 112, 113, 114).

11. The method according to any one of claims 8 to 10, comprising setting the second criterion dynamically based on an average level (F_{plt}) of the flow (f(t)) during a plateau phase (Ph_{plt}) preceding the decline phase (Ph_{decl}), such that:

if the average level ($F_{plt}1$) of the flow (f(t)) during the plateau phase (Ph_{plt}) is comparatively high, the second criterion specifies a relatively steep threshold slope (s_{crit1}), and
if the average level ($F_{plt}2$) of the flow (f(t)) during the plateau phase (Ph_{plt}) is comparatively low, the second criterion specifies a relatively gentle threshold slope ($s_{crit}2$).

12. The method according to any one of claims 8 to 10, comprising determining that the second criterion is fulfilled exclusively based on that the at least one flow (f(t); (f_1(t), f_2(t), f_3(t), f_4(t)) decreases faster than the threshold slope ($s_{crit}1$, $s_{crit}2$).

13. The method according to claim 8, comprising setting the third criterion dynamically based on an average level (F_{plt}) of the flow (f(t)) during a plateau phase (Ph_{plt}) preceding the decline phase (Ph_{decl}), such that:

if the average level ($F_{plt}1$) of the flow (f(t)) during the plateau phase (Ph_{plt}) is comparatively high, the third criterion specifies a relatively high threshold level ($F_{th}1$), and
if the average level ($F_{plt}2$) of the flow (f(t)) during the plateau phase (Ph_{plt}) is comparatively low, the third criterion specifies a relatively low threshold level (Ft_h2).

14. The method according to any one of claims 8 to 13, comprising determining the take-off time (t_{TO}) on the further basis of at least one of:

historic milk-yield data for the animal,
historic milk-flow-profile data for the animal,
a current lactation phase of the animal,
an age of the animal, and
a health status of the animal.

15. A computer program (157) loadable into a non-volatile data carrier (153) communicatively connected to a processing unit (150), the computer program (157) comprising software for executing the method according any of the claims 8 to 14 when the computer program (157) is run on the processing unit (150).

Patentansprüche

1. Steuereinheit (150) für ein Melksystem, wobei die Steuereinheit (150) eine Verarbeitungsschaltlogik und Schnittstellen umfasst, die konfiguriert sind zum:

Empfangen mindestens eines Parameters, der mindestens einen gemessenen Fluss (f(t); (f_1(t), f_2(t), f_3(t), f_4(t)) von Milch darstellt, die von mindestens einer Zitze eines Euters (105) eines Tieres entnommen wird, das über mindestens einen Zitzenbecher (111, 112, 113, 114) gemolken wird, und basierend auf dem mindestens einen Parameter
Steuern (Ctrl) des Anhaltens der Entnahme von Milch, wobei die Verarbeitungsschaltlogik konfiguriert ist, um eine Abbruchzeit (t_{TO}) zu bestimmen, zu der das Melken angehalten werden soll, basierend auf:

einem ersten Kriterium, das anzeigt, dass der mindestens eine Fluss (f(t); (f_1(t), f_2(t), f_3(t), f_4(t)) eine Abnahmephase (Ph_{decl}) erreicht hat, und
einem zweiten Kriterium, das anzeigt, dass der mindestens eine Fluss (f(t); (f_1(t), f_2(t), f_3(t), f_4(t)) schneller abnimmt als eine Schwellensteigung ($s_{crit}1$, $s_{crit}2$),
wobei die Abbruchzeit (t_{TO}) als Reaktion darauf bestimmt wird, ob das zweite Kriterium zu oder nach einem Zeitpunkt (t_1) erfüllt ist, an dem das erste Kriterium erfüllt wurde, und wobei die Verarbeitungsschaltlogik konfiguriert ist, um, wenn das zweite Kriterium nicht erfüllt wurde, die Abbruchzeit (t_{TO}) als weitere Reaktion auf ein drittes Kriterium zu bestimmen, das erfüllt ist, wenn:

nachdem das erste Kriterium angezeigt hat, dass der Fluss (f(t)) die Abnahme-

phase (Ph_{decl}) erreicht hat, der Fluss (f(t)) unter ein Schwellenniveau ($F_{th}1$, $F_{th}2$) abfällt, und
die Verarbeitungsschaltlogik konfiguriert ist, um zu bestimmen, dass der mindestens eine Fluss (f(t); ($f_1(t)$, $f_2(t)$, $f_3(t)$, $f_4(t)$)) basierend auf mindestens einem der folgenden die Abnahmephase (Ph_{decl}) erreicht hat:
einer Reihe von Flusswerten, die während der aktuellen Melkens registriert wurden, und historischen Milchflussprofildaten (D_{mfp}) für das Tier, das gerade gemolken wird.

2. Steuereinheit (150) nach Anspruch 1, wobei der mindestens eine Parameter einen gemeinsamen Milchfluss (f(t)) aus allen Zitzen des Euters (105) des Tieres darstellt.

3. Steuereinheit (150) nach einem der Ansprüche 1 oder 2, wobei das Anhalten der Milchentnahme mindestens eines der folgenden beinhaltet:

Entfernen mindestens eines des mindestens einen Zitzenbechers (111, 112, 113, 114) von einer entsprechenden Zitze des Euters (105),
Abschalten eines Pulsatorvakuums (PV) an mindestens einem des mindestens einen Zitzenbechers (111, 112, 113, 114) und
Abschalten eines Melkvakuums (MV) an mindestens einem des mindestens einen Zitzenbechers (111, 112, 113, 114).

4. Steuereinheit (150) nach einem der vorstehenden Ansprüche, wobei die Verarbeitungsschaltlogik konfiguriert ist, um das zweite Kriterium basierend auf einem durchschnittlichen Niveau (F_{plt}) des Flusses (f(t)) während einer Plateauphase (Ph_{plt}), die der Abnahmephase (Ph_{decl}) vorausgeht, dynamisch festzulegen, so dass:

wenn das durchschnittliche Niveau ($F_{plt}1$) des Flusses (f(t)) während der Plateauphase (Ph_{plt}) vergleichsweise hoch ist, das zweite Kriterium eine relativ steile Schwellensteigung ($s_{crit}1$) spezifiziert, und
wenn das durchschnittliche Niveau ($F_{plt}2$) des Flusses (f(t)) während der Plateauphase (Ph_{plt}) vergleichsweise niedrig ist, das zweite Kriterium eine relativ sanfte Schwellensteigerung ($s_{crit}2$) spezifiziert.

5. Steuereinheit (150) nach einem der vorstehenden Ansprüche, wobei die Verarbeitungsschaltlogik konfiguriert ist, um zu bestimmen, dass das zweite Kriterium ausschließlich basierend darauf erfüllt ist, dass der mindestens eine Fluss (f(t); ($f_1(t)$, $f_2(t)$, $f_3(t)$, $f_4(t)$)) schneller abfällt als die Schwellensteigung ($s_{crit}1$, $s_{crit}2$).

6. Steuereinheit (150) nach Anspruch 1, wobei die Verarbeitungsschaltlogik konfiguriert ist, um das dritte Kriterium basierend auf einem durchschnittlichen Niveau (F_{plt}) des Flusses (f(t)) während einer Plateauphase (Ph_{plt}), die der Abnahmephase (Ph_{decl}) vorausgeht, dynamisch festzulegen, so dass:

wenn das durchschnittliche Niveau ($F_{plt}1$) des Flusses (f(t)) während der Plateauphase (Ph_{plt}) vergleichsweise hoch ist, das dritte Kriterium ein relativ hohes Schwellenniveau ($F_{th}1$) spezifiziert, und
wenn das durchschnittliche Niveau ($F_{plt}2$) des Flusses (f(t)) während der Plateauphase (Ph_{plt}) vergleichsweise niedrig ist, das dritte Kriterium ein relativ niedriges Schwellenniveau ($F_{th}2$) spezifiziert.

7. Steuereinheit (150) nach einem der vorstehenden Ansprüche, wobei die Verarbeitungsschaltlogik konfiguriert ist, um die Abbruchzeit (t_{TO}) auf der weiteren Basis von mindestens einem der folgenden zu bestimmen:

historischen Milchleistungsdaten für das Tier,
historischen Milchflussprofildaten für das Tier,
einer aktuellen Laktationsphase des Tieres,
einem Alter des Tieres, und
einem Gesundheitszustand des Tieres.

8. Automatisches Melkverfahren, umfassend:

Empfangen mindestens eines Parameters, der mindestens einen gemessenen Fluss (f(t); ($f_1(t)$, $f_2(t)$, $f_3(t)$, $f_4(t)$)) von Milch darstellt, die von mindestens einer Zitze eines Euters (105) eines Tieres entnommen wird, das über mindestens einen Zitzenbecher (111, 112, 113, 114) gemolken wird, und basierend auf dem mindestens einen Parameter
Steuern (Ctrl) des Anhaltens der Entnahme von Milch, Bestimmen einer Abbruchzeit (t_{TO}), zu der das Melken angehalten werden soll, basierend auf:

einem ersten Kriterium, das anzeigt, dass der mindestens eine Fluss (f(t); ($f_1(t)$, $f_2(t)$, $f_3(t)$, $f_4(t)$)) eine Abnahmephase (Ph_{decl}) erreicht hat, und
einem zweiten Kriterium, das anzeigt, dass der mindestens eine Fluss (f(t); ($f_1(t)$, $f_2(t)$, $f_3(t)$, $f_4(t)$)) schneller als eine Schwellensteigung (s_{crit} 1, $s_{crit}2$) abfällt,
wobei die Abbruchzeit (t_{TO}) als Reaktion darauf bestimmt wird, ob das zweite Krite-

rium zu oder nach einem Zeitpunkt (t_1) erfüllt ist, zu dem das erste Kriterium erfüllt wurde, und, falls das zweite Kriterium nicht erfüllt wurde: Bestimmen der Abbruchzeit (t_{TO}) als weitere Reaktion auf ein drittes Kriterium, das erfüllt ist, wenn:

nachdem das erste Kriterium angezeigt hat, dass der Fluss (f(t)) die Abnahmephase (Ph_{decl}) erreicht hat, der Fluss (f(t)) unter ein Schwellenniveau ($F_{th}1$, $F_{th}2$) abfällt, und
wenn das Bestimmen, dass der mindestens eine Fluss (f(t); ($f_1(t)$, $f_2(t)$, $f_3(t)$, $f_4(t)$) die Abnahmephase (Ph_{decl}) erreicht hat, auf mindestens einem der folgenden basiert:
einer Reihe von Flusswerten, die während der aktuellen Melkens registriert wurden, und historischen Milchflussprofildaten (D_{mfp}) für das Tier, das gerade gemolken wird.

9. Verfahren nach Anspruch 8, wobei der mindestens eine Parameter einen gemeinsamen Milchfluss (f(t)) aus allen Zitzen des Euters (105) des Tieres darstellt.

10. Verfahren nach einem der Ansprüche 8 oder 9, wobei das Anhalten der Entnahme von Milch mindestens eines der folgenden beinhaltet:

Entfernen mindestens eines des mindestens einen Zitzenbechers (111, 112, 113, 114) von einer entsprechenden Zitze des Euters (105),
Abschalten eines Pulsatorvakuums (PV) an mindestens einem des mindestens einen Zitzenbechers (111, 112, 113, 114) und
Abschalten eines Melkvakuums (MV) an mindestens einem des mindestens einen Zitzenbechers (111, 112, 113, 114).

11. Verfahren nach einem der Ansprüche 8 bis 10, umfassend das Festlegen des zweiten Kriteriums, basierend auf einem durchschnittlichen Niveau (F_{plt}) des Flusses (f(t)) während einer Plateauphase (Ph_{plt}), die der Abnahmephase (Ph_{decl}) vorausgeht, so dass:

wenn das durchschnittliche Niveau ($F_{plt}1$) des Flusses (f(t)) während der Plateauphase (Ph_{plt}) vergleichsweise hoch ist, das zweite Kriterium eine relativ steile Schwellensteigung ($s_{crit}1$) spezifiziert, und
wenn das durchschnittliche Niveau ($F_{plt}2$) des Flusses (f(t)) während der Plateauphase (Ph_{plt}) vergleichsweise niedrig ist, das zweite Kriterium eine relativ sanfte Schwellensteigerung ($s_{crit}2$) spezifiziert.

12. Verfahren nach einem der Ansprüche 8 bis 10, umfassend das Bestimmen, dass das zweite Kriterium erfüllt ist, ausschließlich basierend darauf, dass der mindestens eine Fluss (f(t); ($f_1(t)$, $f_2(t)$, $f_3(t)$, $f_4(t)$) schneller abfällt als die Schwellensteigung ($s_{crit}1$, $s_{crit}2$).

13. Verfahren nach Anspruch 8, umfassend das dynamische Festlegen des dritten Kriteriums, basierend auf einem durchschnittlichen Niveau (F_{plt}) des Flusses (f(t)) während einer Plateauphase (Ph_{plt}), die der Abnahmephase (Ph_{decl}) vorausgeht, so dass:

wenn das durchschnittliche Niveau ($F_{plt}1$) des Flusses (f(t)) während der Plateauphase (Ph_{plt}) vergleichsweise hoch ist, das dritte Kriterium ein relativ hohes Schwellenniveau ($F_{th}1$) spezifiziert, und
wenn das durchschnittliche Niveau ($F_{plt}2$) des Flusses (f(t)) während der Plateauphase (Ph_{plt}) vergleichsweise niedrig ist, das dritte Kriterium ein relativ niedriges Schwellenniveau ($F_{th}2$) spezifiziert.

14. Verfahren nach einem der Ansprüche 8 bis 13, umfassend das Bestimmen der Abbruchzeit (t_{TO}), weiterhin basierend auf mindestens einem der folgenden:

historischen Milchleistungsdaten für das Tier,
historischen Milchflussprofildaten für das Tier,
einer aktuellen Laktationsphase des Tieres,
einem Alter des Tieres, und
einem Gesundheitszustand des Tieres.

15. Computerprogramm (157), das in einen nichtflüchtigen Datenträger (153) geladen werden kann, der kommunikativ mit einer Verarbeitungseinheit (150) verbunden ist, wobei das Computerprogramm (157) Software zum Ausführen des Verfahrens nach einem der Ansprüche 8 bis 14 umfasst, wenn das Computerprogramm (157) auf der Verarbeitungseinheit (150) ausgeführt wird.

Revendications

1. Unité de commande (150) pour un système de traite, l'unité de commande (150) comprenant des circuits de traitement et des interfaces configurés pour :

recevoir au moins un paramètre représentant au moins un débit mesuré (f(t) ; ($f_1(t)$, $f_2(t)$, $f_3(t)$, $f_4(t)$) du lait en cours d'extraction d'au moins un trayon d'un pis (105) d'un animal trait par l'intermédiaire d'au moins un gobelet trayeur (111,

112, 113, 114), et, sur la base dudit au moins un paramètre
commander (Ctrl) l'arrêt de l'extraction du lait, dans lequel les circuits de traitement sont configurés pour déterminer un moment de retrait (t_{TO}) auquel la traite doit être arrêtée sur la base de :

un premier critère indiquant que l'au moins un débit (f(t) ; ($f_1(t)$, $f_2(t)$, $f_3(t)$, $f_4(t)$)) a atteint une phase de déclin (Ph_{decl}), et
un deuxième critère indiquant que l'au moins un débit (f(t) ; ($f_1(t)$, $f_2(t)$, $f_3(t)$, $f_4(t)$)) diminue plus rapidement qu'une pente seuil ($s_{crit}1$, $s_{crit}2$),
le moment de retrait (t_{TO}) étant déterminé en réponse au fait que le deuxième critère est rempli à un moment (ti) ou après un moment (ti) où le premier critère a été rempli, et, si le deuxième critère n'a pas été rempli, les circuits de traitement sont configurés pour déterminer le moment de retrait (t_{TO}) en réponse en outre à un troisième critère, qui est rempli si :

après que le premier critère a indiqué que le débit (f(t)) a atteint la phase de déclin (Ph_{decl}), le débit (f(t)) descend en dessous d'un niveau seuil ($F_{th}1$, $F_{th}2$), et
les circuits de traitement sont configurés pour déterminer que l'au moins un débit (f(t) ; ($f_1(t)$, $f_2(t)$, $f_3(t)$, $f_4(t)$)) a atteint la phase de déclin (Ph_{decl}) sur la base d'au moins l'un parmi :
une série de valeurs de débit enregistrées pendant une traite en cours, et
des données historiques de profil de débit de lait (D_{mfp}) pour l'animal en cours de traite.

2. Unité de commande (150) selon la revendication 1, dans laquelle l'au moins un paramètre représente un débit de lait commun (f(t)) provenant de tous les trayons du pis (105) de l'animal.

3. Unité de commande (150) selon l'une quelconque des revendications 1 ou 2, dans laquelle l'arrêt de l'extraction de lait implique au moins l'un parmi :

le décrochage d'au moins l'un des gobelets trayeurs (111, 112, 113, 114) d'un trayon respectif du pis (105),
l'arrêt d'un vide de pulsateur (PV) pour au moins l'un de l'au moins un gobelet trayeur (111, 112, 113, 114), et
l'arrêt d'un vide de traite (MV) pour au moins l'un de l'au moins un gobelet trayeur (111, 112, 113, 114).

4. Unité de commande (150) selon l'une quelconque des revendications précédentes, dans laquelle les circuits de traitement sont configurés pour régler le deuxième critère dynamiquement sur la base d'un niveau moyen (F_{plt}) du débit (f(t)) pendant une phase de plateau (Ph_{plt}) précédant la phase de déclin (Ph_{decl}), de telle sorte que :

si le niveau moyen ($F_{plt}1$) du débit (f(t)) pendant la phase de plateau (Ph_{plt}) est comparativement élevé, le deuxième critère spécifie une pente seuil relativement raide ($s_{crit}1$), et
si le niveau moyen ($F_{plt}2$) du débit (f(t)) pendant la phase de plateau (Ph_{plt}) est comparativement faible, le deuxième critère spécifie une pente seuil relativement douce ($s_{crit}2$).

5. Unité de commande (150) selon l'une quelconque des revendications précédentes, dans laquelle les circuits de traitement sont configurés pour déterminer que le deuxième critère est rempli exclusivement sur la base du fait que l'au moins un débit (f(t) ; ($f_1(t)$, $f_2(t)$, $f_3(t)$, $f_4(t)$)) diminue plus rapidement que la pente seuil ($s_{crit}1$, $s_{crit}2$).

6. Unité de commande (150) selon la revendication 1, dans laquelle le circuit de traitement est configuré pour définir le troisième critère dynamiquement sur la base d'un niveau moyen (F_{plt}) du débit (f(t)) pendant une phase de plateau (Ph_{plt}) précédant la phase de déclin (Ph_{decl}), de telle sorte que :

si le niveau moyen ($F_{plt}1$) du débit (f(t)) pendant la phase de plateau (Ph_{plt}) est comparativement élevé, le troisième critère spécifie un niveau seuil relativement élevé ($F_{th}1$), et
si le niveau moyen ($F_{plt}2$) du débit (f(t)) pendant la phase de plateau (Ph_{plt}) est comparativement faible, le troisième critère spécifie un niveau seuil relativement faible (Ft_h2).

7. Unité de commande (150) selon l'une quelconque des revendications précédentes, dans laquelle les circuits de traitement sont configurés pour déterminer le moment de retrait (t_{TO}) sur la base d'au moins l'un parmi :

des données historiques de rendement laitier de l'animal,
des données historiques de profil de débit de lait de l'animal,
une phase de lactation actuelle de l'animal,
l'âge de l'animal, et
un état de santé de l'animal.

8. Procédé de traite automatique comprenant :

la réception d'au moins un paramètre représentant au moins un débit mesuré ($f(t)$; ($f_1(t)$, $f_2(t)$, $f_3(t)$, $f_4(t)$)) du lait en cours d'extraction d'au moins un trayon d'un pis (105) d'un animal trait par l'intermédiaire d'au moins un gobelet trayeur (111, 112, 113, 114), et, sur la base dudit au moins un paramètre

la commande (Ctrl) de l'arrêt de l'extraction du lait, en déterminant le moment de retrait (t_{TO}) auquel la traite doit être arrêtée sur la base de :

un premier critère indiquant que l'au moins un débit ($f(t)$; ($f_1(t)$, $f_2(t)$, $f_3(t)$, $f_4(t)$)) a atteint une phase de déclin (Ph_{decl}), et

un deuxième critère indiquant que l'au moins un débit ($f(t)$; ($f_1(t)$, $f_2(t)$, $f_3(t)$, $f_4(t)$)) diminue plus rapidement qu'une pente seuil ($s_{crit}1$, $s_{crit}2$),

le moment de retrait (t_{TO}) étant déterminé en réponse au fait que le deuxième critère est rempli à un moment (t_1) ou après un moment (t_1) où le premier critère a été rempli, et si le deuxième critère n'a pas été rempli : la détermination du moment de retrait (t_{TO}) en réponse en outre à un troisième critère, qui est rempli si :

après que le premier critère a indiqué que le débit ($f(t)$) a atteint la phase de déclin (Ph_{decl}), le débit ($f(t)$) descend en dessous d'un niveau seuil ($F_{th}1$, $F_{th}2$), et

la détermination du fait que l'au moins un débit ($f(t)$; ($f_1(t)$, $f_2(t)$, $f_3(t)$, $f_4(t)$)) a atteint la phase de déclin (Ph_{decl}) est basée sur au moins l'un parmi :

une série de valeurs de débit enregistrées pendant une traite en cours, et

des données historiques de profil de débit de lait (D_{mfp}) pour l'animal en cours de traite.

9. Procédé selon la revendication 8, dans lequel l'au moins un paramètre représente un débit de lait commun ($f(t)$) provenant de tous les trayons du pis (105) de l'animal.

10. Procédé selon l'une quelconque des revendications 8 ou 9, dans lequel l'arrêt de l'extraction de lait implique au moins l'un parmi :

le décrochage d'au moins l'un des gobelets trayeurs (111, 112, 113, 114) d'un trayon respectif du pis (105),

l'arrêt d'un vide de pulsateur (PV) pour au moins l'un de l'au moins un gobelet trayeur (111, 112, 113, 114), et

l'arrêt d'un vide de traite (MV) pour au moins l'un de l'au moins un gobelet trayeur (111, 112, 113, 114).

11. Procédé selon l'une quelconque des revendications 8 à 10, comprenant le réglage dynamique du deuxième critère sur la base d'un niveau moyen (F_{plt}) du débit ($f(t)$) pendant une phase de plateau (Ph_{plt}) précédant la phase de déclin (Ph_{decl}), de telle sorte que :

si le niveau moyen ($F_{plt}1$) du débit ($f(t)$) pendant la phase de plateau (Ph_{plt}) est comparativement élevé, le deuxième critère spécifie une pente seuil relativement raide ($s_{crit}1$), et

si le niveau moyen ($F_{plt}2$) du débit ($f(t)$) pendant la phase de plateau (Ph_{plt}) est comparativement faible, le deuxième critère spécifie une pente seuil relativement douce ($s_{crit}2$).

12. Procédé selon l'une quelconque des revendications 8 à 10, comprenant la détermination du fait que le deuxième critère est rempli exclusivement sur la base du fait que l'au moins un débit ($f(t)$; ($f_1(t)$, $f_2(t)$, $f_3(t)$, $f_4(t)$)) diminue plus rapidement que la pente seuil ($s_{crit}1$, $s_{crit}2$).

13. Procédé selon la revendication 8, comprenant le réglage dynamique du troisième critère sur la base d'un niveau moyen (F_{plt}) du débit ($f(t)$) pendant une phase de plateau (Ph_{plt}) précédant la phase de déclin (Ph_{decl}), de telle sorte que :

si le niveau moyen ($F_{plt}1$) du débit ($f(t)$) pendant la phase de plateau (Ph_{plt}) est comparativement élevé, le troisième critère spécifie un niveau seuil relativement élevé ($F_{th}1$), et

si le niveau moyen ($F_{plt}2$) du débit ($f(t)$) pendant la phase de plateau (Ph_{plt}) est comparativement faible, le troisième critère spécifie un niveau seuil relativement faible (Ft_h2).

14. Procédé selon l'une quelconque des revendications 8 à 13, comprenant la détermination du moment de retrait (t_{TO}) sur la base en outre d'au moins l'un parmi :

des données historiques de rendement laitier de l'animal,

des données historiques de profil de débit de lait de l'animal,

une phase de lactation actuelle de l'animal,

l'âge de l'animal, et

un état de santé de l'animal.

15. Programme informatique (157) pouvant être chargé sur un support de données non volatile (153) connecté de manière communicative à une unité de traitement (150), le programme informatique (157) comprenant un logiciel pour l'exécution du procédé selon l'une quelconque des revendications 8 à 14 lorsque le programme informatique (157) est exécuté sur l'unité de traitement (150).

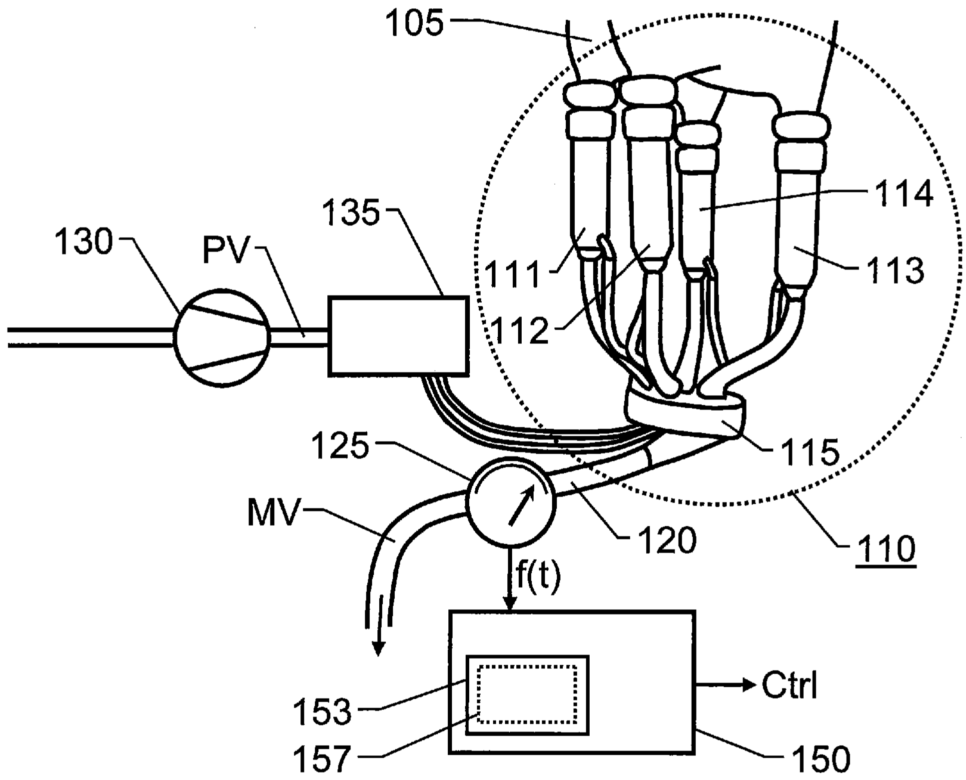
105
130
PV
135
114
111
113
112
115
125
MV
120
110
f(t)
Ctrl
153
157
150

Fig. 1

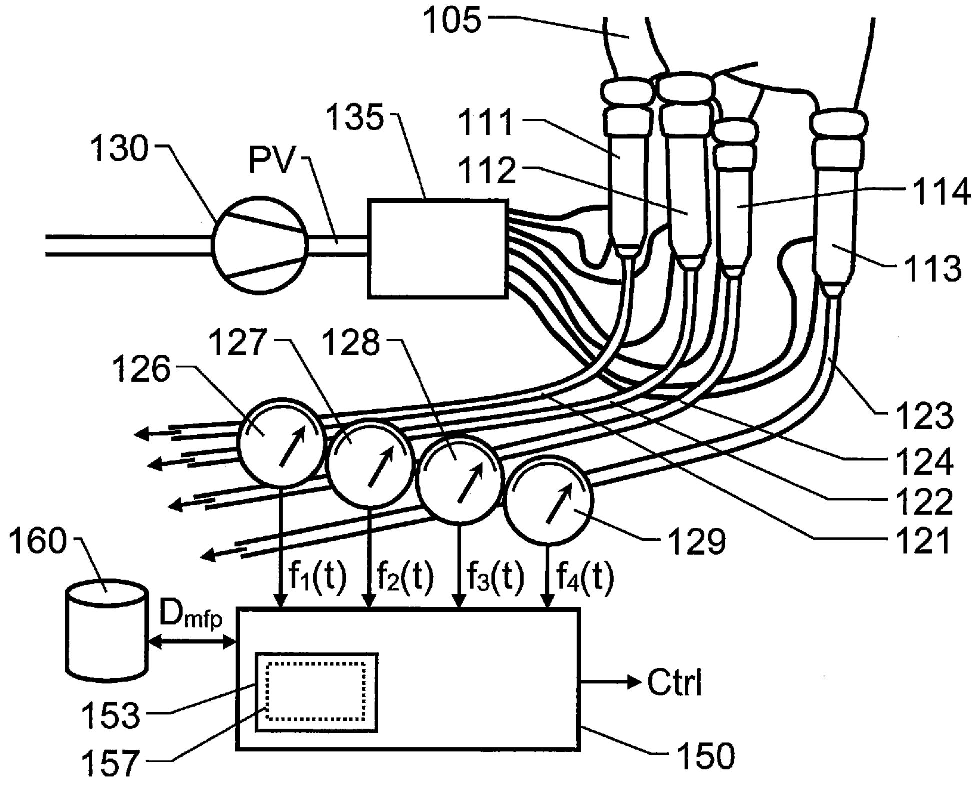
105
135
111
130
PV
112
114
113
127
128
126
123
124
122
121
129
160
$f_1(t)$
$f_2(t)$
$f_3(t)$
$f_4(t)$
D_{mfp}
Ctrl
153
157
150

Fig. 2

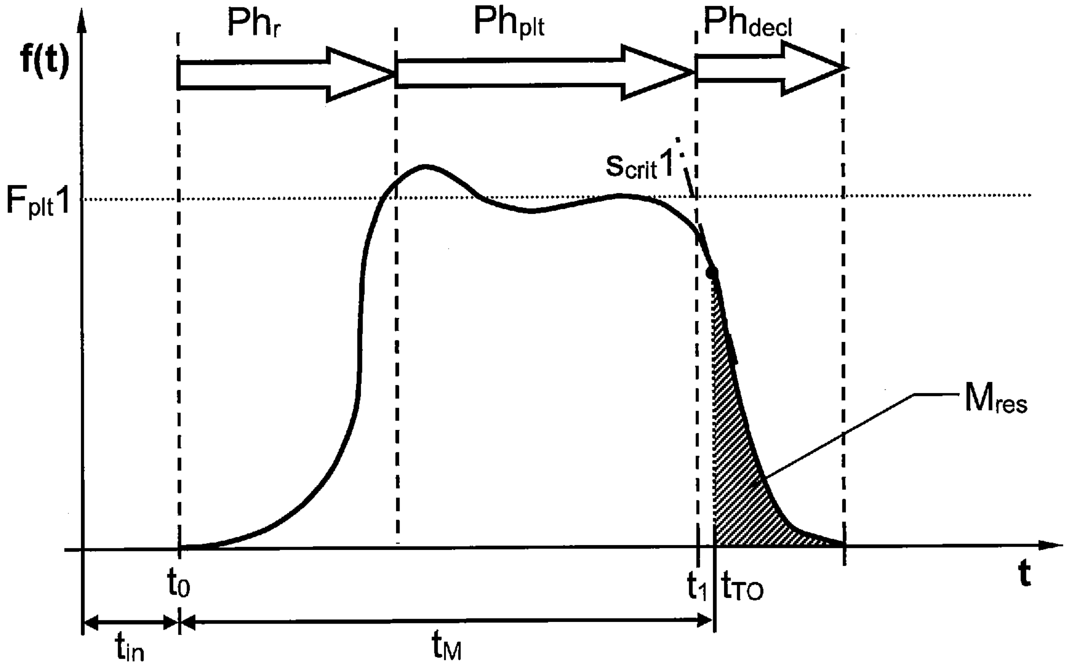
Phr
Phplt
Phdecl
f(t)
scrit1
Fplt1
Mres
t0
t1
tTO
t
tin
tM

Fig. 3a

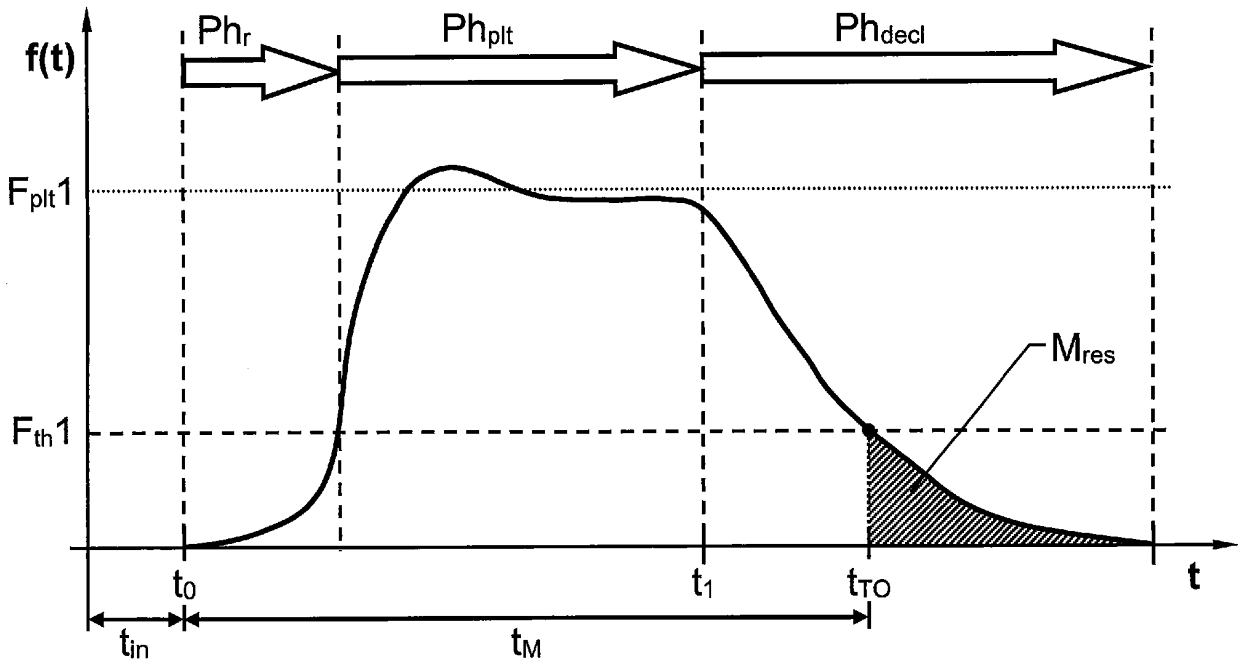
Phr
Phplt
Phdecl
f(t)
Fplt1
Mres
Fth1
t0
t1
tTO
t
tin
tM

Fig. 3b

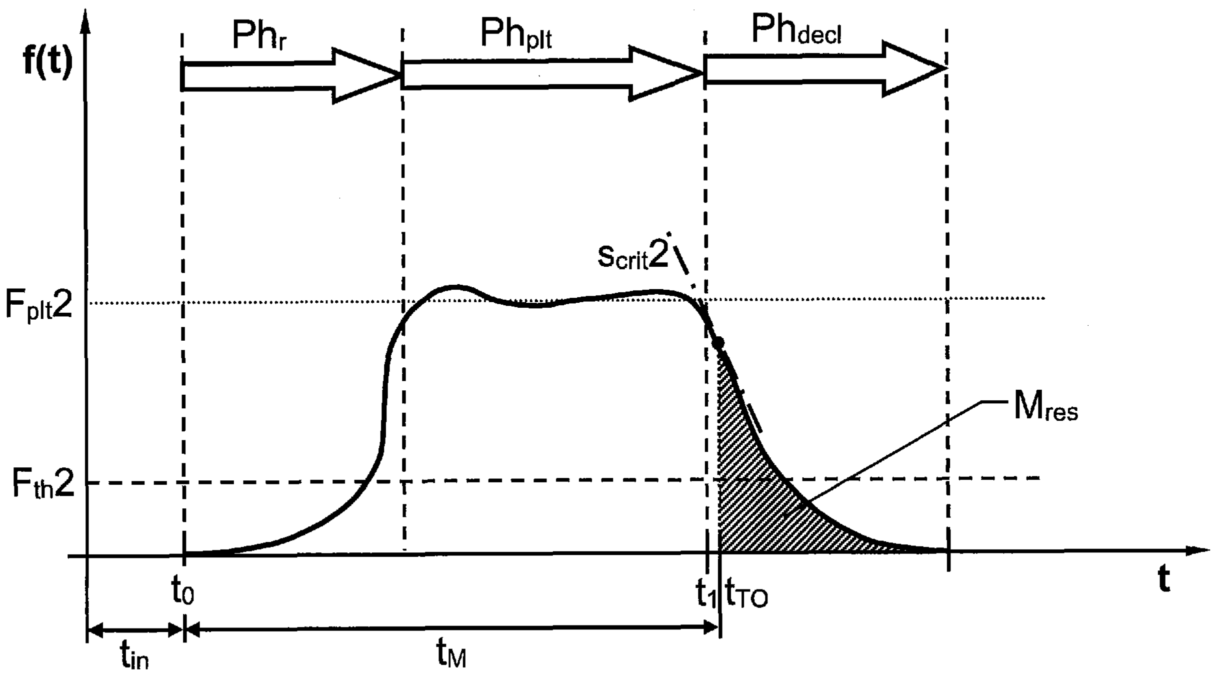

Fig. 3c

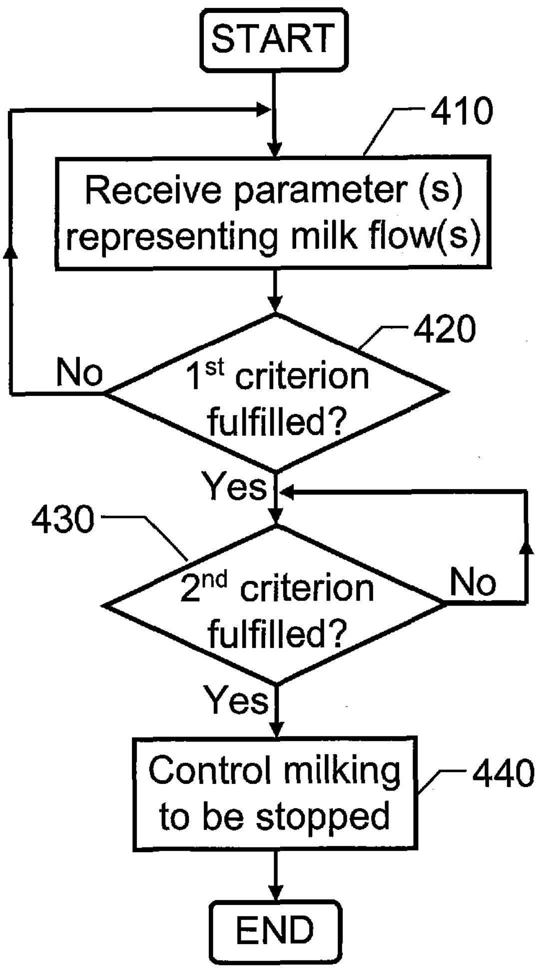

Fig. 4

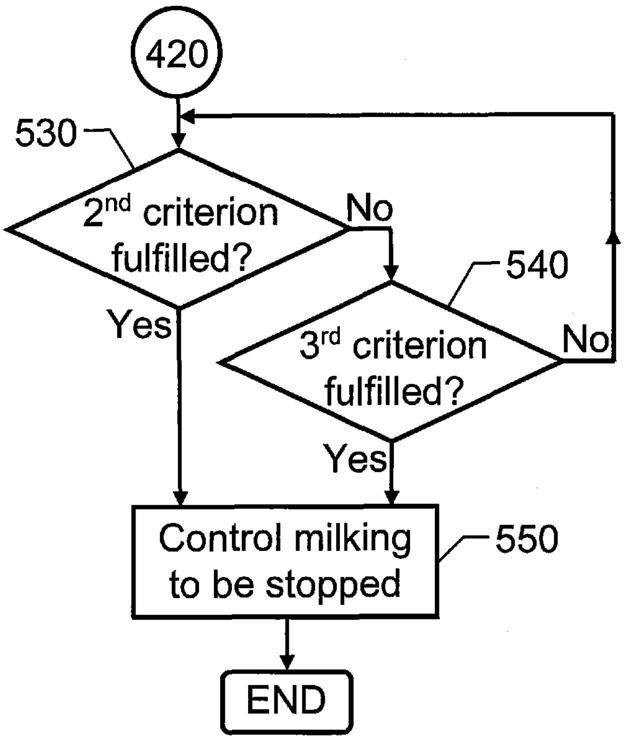

Fig. 5

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- DE 3609275 A1 **[0003]**
- WO 03000042 A1 **[0004]**